

Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/B.Tech(BT)/SEM-5/CHE-514/2009-10  
2009**

**TRANSFER OPERATION – II**

Time Allotted : 3 Hours

Full Marks : 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

**GROUP – A**

**( Multiple Choice Type Questions )**

1. Choose the correct alternatives for any *ten* of the following :

10 × 1 = 10

i) The diffusivity (D) in a binary gas mixture is related to the temperature (T) as

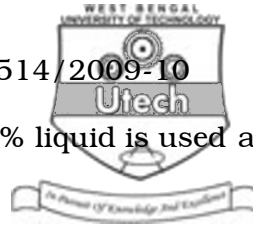
- |                        |                        |
|------------------------|------------------------|
| a) $D \propto T$       | b) $D \propto T^{0.5}$ |
| c) $D \propto T^{1.5}$ | d) $D \propto T^2$ .   |

ii) Mass Transfer Co-efficient (K) and diffusivity (D) are related according to the film theory

- |                        |                        |
|------------------------|------------------------|
| a) $K \propto D$       | b) $K \propto D^{1/2}$ |
| c) $K \propto D^{1.5}$ | d) $K \propto D^2$ .   |



- iii) The slope of operating line for the stripping section of distillation column is
- a) 0    b)  $\infty$   
c)  $< 1$                                       d)  $> 1$ .
- iv) Schmidt Number is analogous to
- a) Prandtl Number                      b) Sherwood Number  
c) Nusselt Number                      d) Froude Number.
- v) In azeotropic mixture, the equilibrium vapour composition is
- a) more than liquid composition  
b) less than liquid composition  
c) same as liquid composition  
d) none of these.
- vi) What is reflux ratio at total reflux ?
- a) Zero    b) Infinity  
c) Unity    d) None of these.
- vii) During drying of a solid, the lowest moisture content is denoted as
- a) critical moisture content  
b) equilibrium moisture content  
c) free moisture content  
d) bound moisture content.
- viii) Rayleigh equation is applicable to
- a) azeotropic distillation              b) batch distillation  
c) steam distillation                    d) fractional distillation.



- ix) A vapour-liquid mixture containing 75% liquid is used as feed for distillation. The value of  $q$  is
- a)  $\frac{3}{4}$     b)  $\frac{1}{4}$
- c)  $\frac{1}{2}$     d) 1.
- x) At total reflux condition in a distillation column, the number of plates becomes
- a) minimum
- b) infinite
- c) more than that predicted by McCabe-Thiele method
- d) less than that predicted by McCabe-Thiele method.
- xi) Which of the following is / are not a membrane separation process ?
- a) Ultrafiltration    b) Reverse osmosis
- c) Electrodialysis    d) None of these.
- xii) Leaching is
- a) Gas - Liquid mass transfer
- b) Gas - Solid mass transfer
- c) Liquid - Liquid mass transfer
- d) Solid - Liquid mass transfer.

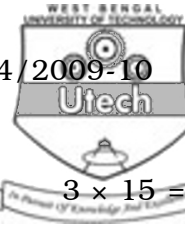


**GROUP – B**

**( Short Answer Type Questions )**

Answer any *three* of the following.  $3 \times 5 = 15$

2. Define reflux ratio. Write down the basic assumptions of McCabe-Thiele method for calculation of number of ideal plates in a distillation operation.  $2 + 3$
3. A binary mixture of benzene and toluene containing 40 mol% benzene is to be distilled at atmospheric pressure to recover 95% of the benzene. Estimate the molal per cent of the mixture which should be distilled and the composition of the distillate obtained, if the distillation is carried out by simple equilibrium distillation.
4. Define the following :  $5 \times 1$ 
  - a) Free moisture
  - b) Unbound moisture
  - c) Bound moisture
  - d) Equilibrium moisture
  - e) Relative humidity.
5. Explain the operating principle of a spray drier.
6. Describe the operating principle of reverse osmosis & its application in industry.

**GROUP – C**Answer any *three* of the following.  $3 \times 15 = 45$ 

7. 100 kg/hr of a nicotine-water solution containing 0.10 wt fraction of nicotine is extracted containing 0.0006 wt fraction nicotine in a countercurrent stage column. The concentration of nicotine is 0.0010 wt fraction in the exit water. Determine the theoretical stages required for the above separation. The solvent kerosene rate is 1.5 times the minimum solvent rate.

The equilibrium data for the above system is as follows :

$x = \text{kg}$ nicotine/kg water	0.001011	0.00246	0.00502	0.00751	0.00998	0.0204
$y = \text{kg}$ nicotine/kg kerosene	0.0005807	0.001961	0.00456	0.00686	0.00913	0.01870

15

8. A continuous fractionating column is to be designed to separate 350 gm-moles per minute of a binary mixture containing 40% ( by weight ) of benzene and 60% ( by weight ) of toluene. The top product contains 97% ( by weight ) of benzene and the bottom product contains 98% ( by weight ) toluene. A reflux ratio of 3.5 moles to 1 mole of product is to be used. The feed is entering the column at its boiling point.
- a) Determine the number of ideal plates.

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- b) Calculate the moles of overhead product and bottom product :

Mol.wt. of benzene = 78

Mol. wt. of toluene = 92

Equilibrium data :

x	0	0.100	0.20	0.30	0.40	0.50
y	0	0.185	0.36	0.50	0.61	0.70
x	0.60	0.70	0.80	0.90	1.0	
y	0.78	0.84	0.90	0.95	1.0	

9 + 6

9. Explain the following terms :

$$7 \frac{1}{2} + 7 \frac{1}{2}$$

- i) Knudsen Diffusion
  - ii) Thermal Diffusion.
10. a) Define HTU and NTU.
- b) What is the absorption factor (  $A$  ) ? Draw the representative freehand graphs to show the nature and relative position of operating line and equilibrium line for an absorption system for the cases of  $A < 1$ ,  $A = 1$ ,  $A > 1$ .



- c) A packed tower is to be designed to absorb  $\text{SO}_2$  from air by scrubbing the gas with water. The entering gas is 20%  $\text{SO}_2$  by volume and the leaving gas is to contain 0.5%  $\text{SO}_2$  by volume. The air flow rate (  $\text{SO}_2$  free basis ) is  $975 \text{ kg/hr. m}^2$  . The temperature is  $30^\circ\text{C}$  and the total pressure is 2 atm. The equilibrium data is governed by  $y = 21.8x$  where  $x$  and  $y$  are in mole fraction units. Compute the number of overall gas phase transfer units. 2 + 5 + 8

11. a) Draw the schematic for electro dialysis.
- b) What is osmosis ? How is it related to the temperature ?
- c) Define crystallization. Describe Meir's theory of crystallization. 4 + 4 + 7

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